MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EME4076 – MECHANICAL VIBRATIONS

(ME)

2 MARCH 2020
2:30 – 4:30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1.This exam paper consists of only four printed pages, including this cover page.

2. Answer all questions.

3. Write all your answers in the answer booklet provided.

Question 1

a) Use Raleigh's method, or otherwise, to find the natural frequency of the pulley system shown in Fig. 1a. Neglect the friction and the masses of the pulleys. [15 marks]

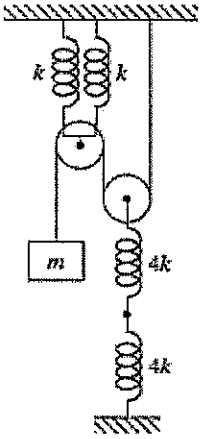

Figure 1a

b) The electric motor turns an eccentric flywheel which is equivalent to an unbalanced 0.125-kg weight located 250 mm from the axis of rotation. See Fig. 1b. If the static deflection of the beam is 25 mm due to the weight of the motor, determine the angular velocity of the flywheel at which resonance will occur. The motor weights 75 kg. Neglect the mass of the beam. [5 marks]

Figure 1b

c) Explain how most vibrations are undesirable in mechanical engineering. [5 marks]

Question 2

a) A single-story building frame is subjected to a harmonic ground acceleration, as shown in Fig. 2a. Find the steady-state motion of the floor (mass m). [15 marks]

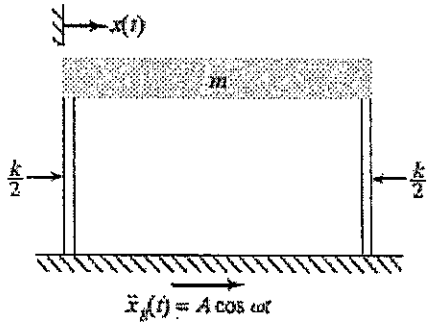

Figure 2a

b) A spring-mass system is subjected to Coulomb damping. When a harmonic force of amplitude 120 N and frequency 2.5173268 Hz is applied, the system oscillates with amplitude of 75 mm. Explain why the frequency is expressed in eight significant figures. Also, determine the coefficient of dry friction if $m = 2$ kg and $k = 2100$ N/m. [10 marks]

Continued . . .

Question 3

a) Fig. 3a shows two-degree-of-freedom systems. If the $m_1 = 1$ kg, $m_2 = 2$ kg, $k_1 = 50$ N/m, and $k_2 = 100$ N/m,

i) derive the equation of motion of the systems in matrix form. [8 marks]

ii) determine the natural frequencies of the systems. [5 marks]

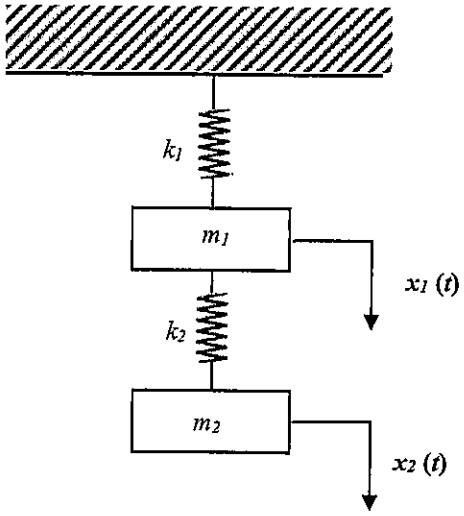

Figure 3a

b) Using Lagrange equation, derive the differential equations governing the motion for the system shown in Fig. 3b. Hence, write the differential equation in matrix form. [12 marks]

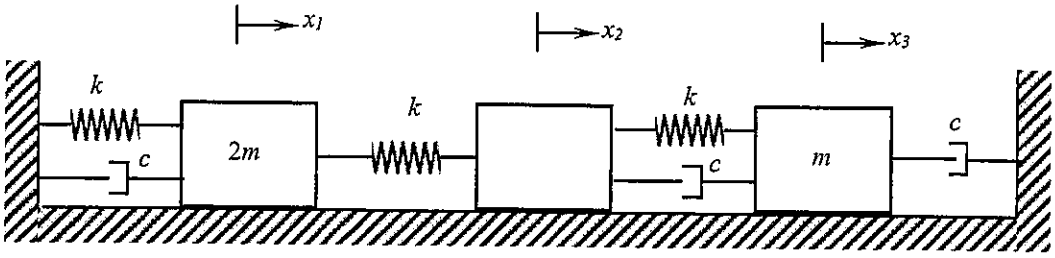

Figure 3b

Continued . . .

Question 4

a) In an experiment, a steel wire of 1.5 mm diameter is fixed between two points located 1.5 m apart. The tensile force in the wire is 100 N. Given the density of the material is 7830 kg/m^3, determine

i) the velocity of the wave propagation in the wire, and [5 marks]

ii) the fundamental frequency of vibration. [5 marks]

b) Derive an equation for the principal modes of longitudinal vibration of a uniform bar having both ends free where the boundary conditions are $\frac{\partial u(0,t)}{\partial x} = 0$ and $\frac{\partial u(l,t)}{\partial x} = 0$.

Use $u(x,t) = \left(\tilde{A}\cos\frac{\omega x}{c} + B\ \sin\frac{\omega x}{c}\right)(C\cos\omega t + B\ \sin\omega t)$ as governing equation.

[15 marks]

End of Paper